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MONOGRAPH OF *CERATODISCUS*  
(ARCHAEOGASTROPODA; HELICINIDAE)

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**ABSTRACT.** Three species, one each from Cuba, Hispaniola, and Puerto Rico, are recognized in the helicimid genus *Ceratodiscus*. All are minute, have an unique operculum and the unusual habit of covering the shell with a bicarinate incrustation. These characters are considered sufficient to place the genus in a separate subfamily, the *Ceratodiscinae*.

INTRODUCTION

The present paper constitutes one of a series of monographs on the helicimid groups of Cuba. Previous revisions covered the genera: *Viana*, *Priotrochatella*, *Emoda*, *Glyptemoda*, *Calidviana*, *Ustronia*, *Troschelviana*, *Semitrochatella*, and *Alcadia* (Clench and Jacobson, 1968; 1970; 1971 a & b; Boss and Jacobson, in press). In the case of *Ceratodiscus*, so few species are known in the West Indies and only one in Cuba, that it was decided to revise the entire group.

Six nominal specific-level taxa have been assigned to *Ceratodiscus*. Our study indicates that only 3 very closely related species can be recognized. The Cuban *C. minimus* is distributed in the eastern provinces, Camagüey and Oriente. The Hispaniolan species, *C. solutus*, the type-species of the genus lives in western Santo Domingo, Haiti

and the off-shore islands of Tortuga and Beata. *Ceratodiscus portoricanus* occurs principally in the western part of the island of Puerto Rico. This relict pattern may be interpreted as indicating the close zoogeographical relationship of the three larger Greater Antilles.

Although there is no available fossil evidence to explain the phylogenetic derivation of the species of *Ceratodiscus*, the present day distribution suggests that Hispaniola may have formed the population center from whence *minimus* and *portoricanus* were derived. Immature specimens of *C. solutus* approach the Cuban and Puerto Rican species in being largely adnate, having a much shorter portion of the last whorl solute.

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#### ABBREVIATIONS

ANSP — Academy of Natural Sciences of Philadelphia  
 MCZ — Museum of Comparative Zoology  
 UMMZ — University of Michigan Museum of Zoology  
 USNM — National Museum of Natural History

#### HISTORICAL REMARKS

The earliest known *Ceratodiscus* was described as *Cyclostus minimus* by Pfeiffer (1859) who, with some hesitation, placed it in the Cyclophoridae. He averred that the systematic assignation of the species was questionable in that the nature of the operculum actually excluded it from the true Cyclostomatidae (= Cyclophoridae). Later with the discovery of fresh specimens, Pfeiffer and Gundlach (1860) noted the unusual habit exhibited by this species, namely

the formation of an adhering black incrustation which covers the shell and imparts a bicarinate appearance to its outline. He still maintained that the generic relations of the species were "räthselhaft".

Later, *minimus* was referred to *Crocidopoma*, a subgenus of *Aperostoma* in the Cyclophoridae (Kobelt and Möllendorff, 1897; Kobelt, 1902), a placement which has subsequently proven to be incorrect. It is probable that Kobelt's (1902) inclusion of *C. minimus* in the Cyclophoridae occasioned the omission of *Ceratodiscus* in the large monograph of the Helicinidae by Wagner (1907-1908).

The name *Ceratodiscus*<sup>1</sup> was introduced by Simpson and Henderson (1901) for their new species *solutus* from Haiti. They made no statement to justify the erection of a new genus and did not compare it with known forms, but they remarked that it was probably referable to the Cyclotidae (= Cyclophoridae). Further, none of their specimens of *C. solutus* had an operculum so the unusual nature of that structure, so characteristic of the genus, remained for them unknown.

Subsequently in his description of *Ceratodiscus ramsdeni*, the original material of which also lacked an operculum, Pilsbry (1914) placed the genus in the Cyclophoridae. He remarked too that the species, *ramsdeni* and *solutus*, bore a close relationship to "*Cyclotus*" *minimus*.

It was Thiele (1927) who recognized the true familial relationship of *Ceratodiscus*, placing the group in close conjunction with *Stoastoma* C. B. Adams in the Helicinidae on the basis of the radula although he realized how unlike these genera are conchologically. Further, he pointed out that the distinctive operculum characterized *Ceratodiscus* generically. Shortly following, Pilsbry (1927), on the basis of the peculiar operculum with the 'external' nucleus and the tubular whorls of the openly umbilicate shell, proposed the subfamily Ceratodiscinae for the genus and listed the

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<sup>1</sup>Derived from the Greek *keras*, a horn, and *diskos*, a quoit or disk; the generic name probably refers to the thick bicarinate incrusting layer covering many specimens which gives a horned appearance to the shell when it is viewed from the aperture.

known species, including *C. portoricanus* which he and Vanatta (1927) had just described. Subsequently an insular population of *C. solutus* was named as *C. beatensis* by Bartsch (1932).

Baker (1934) remarked on a possible relationship between *Fadyenia*, *Lucidella*, and *Ceratodiscus* and later (1956) stated that they belonged to the same tribe. He was in accord with Pilsbry (1927) and utilized the group name Ceratodiscinae. Earlier, however, Aguayo and Jaume (1948) elevated the taxon to the family level, creating what appears to be a monotypic Ceratodiscidae.

Keen (1960), on the basis of similarities in the radula and maintaining a subfamilial rank, followed Baker (1956) and had the Ceratodiscinae include the genera *Fadyenia* Chitty 1857, — formerly associated with *Stoastoma* C. B. Adams — and *Lucidella* Swainson, 1840.

Keen's (1960) decision to unite the genera *Fadyenia*, *Lucidella*, and *Ceratodiscus* in the subfamily Ceratodiscinae should be re-examined. Anatomical or radular specimens were not available to us. Even though samples with opercula were carefully prepared in sodium triphosphate, no radula was obtained. We are inclined, however, to recognize *Ceratodiscus* as an extremely unique helicimid, placing it in its own, monotypic group, the Ceratodiscinae. The tubular nature of the whorls, slight soluteness, the unusual external bicarinate deposit, and the unique operculum separate *Ceratodiscus* from all known helicimids, and though there may be some radular similarities with *Lucidella* and *Fadyenia* as pointed out by Thiele (1927) and Baker (1934; 1956), that structure as noted subsequently is really imperfectly and incompletely known. Further, zoogeographic considerations point out the uniqueness of *Ceratodiscus vis-a-vis* the genera which Baker related to it. Both *Fadyenia* and *Lucidella* are principally Jamaican with only a few, possibly introduced, species on other West Indian islands; *Ceratodiscus* itself does not occur on Jamaica.

## RADULA

Part of the radula of *C. minimus* Pfeiffer was figured by Thiele (1927). It shows a squarish central rachidian tooth and progressively wider A-, B-, and C- centrals, with 2, 4, and 6 cusps respectively. The large capituliform lateral complex consists of 2 parts: a large comb-lateral with a low terminal shank and 7 strong cusps, and a trapezoidal accessory plate with a larger and smaller wing. Thus, according to the definitions of Baker (1922) and the nomenclature of Boss and Jacobson (in press), *Ceratodiscus* has a typically helicinine radula with a modified R-central tooth and accessory plate. The uncinals of the marginal complex were not figured by Thiele and should be investigated.

Thiele (1927) concluded that *Ceratodiscus* was related to *Stoastoma* and certainly not a cyclophorid. Pilsbry (1927) felt that the radula resembled that of *Lucidella* as figured by Baker (1922), which it most surely does. On the basis of what is known about the radula, *Fadyenia*, *Lucidella*, and *Ceratodiscus* are more closely related to each other than to other heliciniids. But as we have suggested earlier, *Ceratodiscus* itself is exceptionally distinguished on other grounds.

## OPERCULUM

Pfeiffer (1859) noted something of the nature of the operculum in *C. minimus*:

"As can be seen in the accompanying figure, the operculum is most unique. It apparently has no spiral structure; instead there is a series of striae grouped around a lateral nucleus much as in the case of the bivalves."

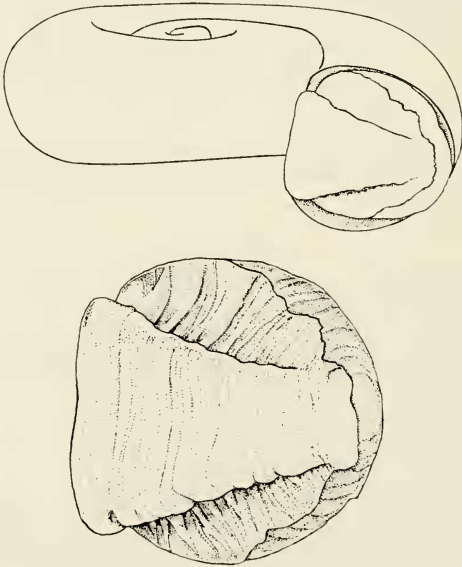
Later, Pilsbry (1914: 133-134) described the operculum of *C. minimus* as being extremely peculiar:

"The nucleus is at the external border. A smooth, wedge-shaped area radiates toward the columellar margin and the area above and below this are lamellose, the lamellae at right angles to the sides of the median wedge. This is quite unlike all known genera of the region."

Subsequently, Thiele (1927: 156, pl. 9, figs. 5 and 6) discussed and figured the operculum:

“Pfeiffer reports that this operculum is without a distinct spiral structure. I have examined it and found it to be entirely without any sign of a spiral. Instead it has a marginal nucleus from which growth proceeds directly toward the opposing side. The operculum consists of two layers: the outer stronger layer is somewhat lamellar; the thin, calcareous inner layer is glossy brown in the region of the nucleus, with a white triangular field on the opposite side some distance away.”

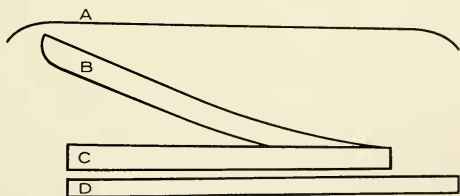
In reviewing Thiele's paper, Pilsbry (1927) restated that the nucleus of the operculum of *Ceratodiscus* was external.



Text-fig. 1. The operculum of *Ceratodiscus portoricanus* Pilsbry and Vanatta 1927. Diameter of shell, 3.0 mm, north of Corozal, Puerto Rico, UMMZ 197310. Drawn by W. Baranowski.

The almost perfectly circular operculum in *Ceratodiscus* is truly unique and very unusual. The lateral nucleus is located on the outer margin of the operculum rather than on the columellar margin; thus, Pilsbry's observations were correct and those of Thiele reversed. However, it is quite difficult to observe the arrangement of layers in the operculum. In specimens of *C. minimus* with a bicarinate incrustation, the operculum is thickly covered externally by a matted, probably mucoid, layer similar to the incrustation. The operculum itself consists of a corneous internal disk upon which is raised a calcareous wedge coextensive with a thin, somewhat latticed, shelly layer, having the nucleus laterally. Text-figure 1 shows the operculum of *C. portoricanus* without the incrusting external layer. The structure is essentially the same as in *C. minimus*. The internal layer is made of a brownish, almost transparent horny material, which serves as a base for the subcircular disk of the calcareous layer and its elevated tongue-like wedge (Text-figure 2).

We suggest that this unusual operculum, particularly its wedge-shaped calcareous structure, is in some way related to the formation of the external bicarinate incrustation on the shell. Perhaps the wedge of the operculum directs mucoid strands with embedded feces or soil from the body or foot of the snail to their position on the whorls of the shell.



Text fig. 2. Diagrammatic cross-section of the operculum of *Ceratodiscus*. A. Outer incrusting layer. B. Raised calcareous wedge. C. Calcareous layer. D. Internal layer of transparent corneous material. Drawn by W. Baranowski.

## Family HELICINIDAE Latreille, 1825

## Subfamily CERATODISCINAE Pilsbry, 1927

Genus *Ceratodiscus* Simpson & Henderson

*Ceratodiscus* Simpson & Henderson, 1901. *Nautilus*, 15: 73 (type-species by monotypy, *Ceratodiscus solutus* Simpson & Henderson, 1901 [Haiti]); Thiele, 1929. *Handbuch systematischen Weichtierkunde* 1: 89–90, figs. 62–64; Wenz, 1938. *Gastropoda* [in] Schindewolf, *Handbuch Palaeozoologie*, p. 447, fig. 1112.

*Description.* Shell small, 2 to 6 mm in diameter, discoidal, umbilicus large, whorls few, tubular, last whorl strongly or weakly solute, surface sculpture weak, shell often incrustated with bicarinate layer in life; aperture sub-circular sometimes flattened at inner margin; operculum unique, with nucleus at outer margin, consisting of external calcareous wedge-shaped portion and internal circular corneous material; periostracum thin, deciduous, with spiral and/or axial periostracal ridges.

REMARKS. Many specimens of all three species discussed in this report are thickly covered with a thick, black or dark brown bicarinate incrustation, under which the periostracal ridges are well preserved. In specimens where this layer is wanting, the ridges are weak or absent, revealing a more or less smooth shell surface, provided only with minute incremental lines and occasional spiral striae. The material of the incrustation was thought to be fecal by Pfeiffer (1869: 446) and mere soil by van der Schalie (1948). Pilsbry (1914) stated that it is held in place by mucus. Among other helicinids that also tend to incrust their shells, often with pseudosculpture, are some genera of the tribe Vianini (Clench & Jacobson, 1971 b). From close examination of museum lots, it would appear that not all living specimens of *Ceratodiscus* bear this incrustation. Evidently it may be associated with definite habitat conditions such as reported by Arango (1879).



As a conchological feature, reabsorption of shelly internal partitions is a characteristic of the Helicinidae (Bland, 1858). Pilsbry (1914) noted this condition in *Ceratodiscus*.

Key to the species of *Ceratodiscus*

1. Body whorl widely solute; Hispaniola . . . . . *solutus*  
 Body whorl not widely solute . . . . . 2
2. Shell briefly solute, with comparatively closely spaced spiral striae; Cuba . . . . . *minimus*  
 Shell appearing briefly solute, but with last whorl minutely tangential to penultimate; spiral striae somewhat more widely spaced; Puerto Rico . *portoricanus*

*Ceratodiscus solutus* Simpson & Henderson

Plate 45, figs. 1-6; Map 1.

*Ceratodiscus solutus* Simpson & Henderson, 1901. Nautilus, 15: 73, pl. 5, figs. 1, 2 (type-locality, La Ferrière, elevation 2,000 feet, northern Haiti; holotype, USNM 490058).

*Ceratodiscus beatensis* Bartsch, 1932. Proc. U. S. National Mus. 81 (6): 5-6, pl. 2, figs. 1-3 (type-locality, Beata Island, off Beata Point, southern coast of Haiti; holotype USNM 403923).

*Description.* Shell reaching nearly 6 mm in diameter, planiform, moderately strong. Whorls little more than 4, tube-shaped, rapidly increasing in size, last whorl more than twice width of penultimate and strongly solute for about 1/3 of its length and slightly deflected terminally; faintly grooved on inner side of solute portion. Color white under a thin, corneous periostracum. Spire depressed, sunk below the level of the body whorl. Aperture slightly oblique, subcircular, columellar margin only slightly flattened; lip thin, entire, barely flaring. Suture well impressed. Surface sculpture of numerous regular, extremely fine, closely set spiral striae. Fine regular growth lines frequently developed to coarse incremental lines. Protoconch about 1 whorl,

smooth, rounded, slightly elevated over earliest portion of teleoconch but sunken below the level of the later whorls. Periostracum glossy, greenish yellow, thin, deciduous, with irregular, low, widely spaced axial and spiral ridges, generally confined to the early teleoconch. Umbilical area wide, deep, showing all the whorls; operculum not observed.

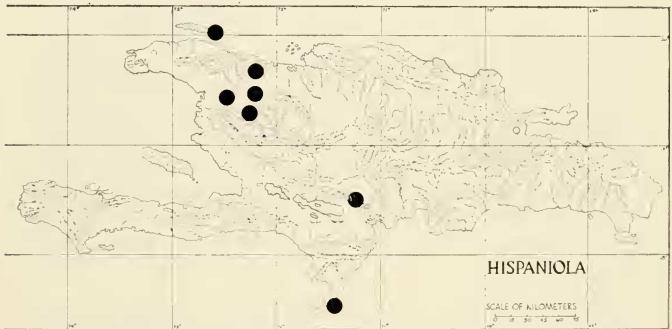
	Greater	Lesser	
Height	Diameter	Diameter	
1.9 mm	5.6 mm	4.4 mm	Bahoruco Mts., Santo Domingo
1.6	5.3	3.4	39.8 mi. S of Cap Haitien, Haiti
1.4	3.9	3.1	Saint Raphaël, Haiti
1.2	4.6	3.3	La Ferrière, Haiti

*Remarks.* In contrast to the Cuban and Puerto Rican species of *Ceratodiscus*, *C. solutus* is distinguished by its greatly solute last whorl, its almost perfectly discoid shape, and its rounded, ovoid aperture.

The finely reticulated sculpture reported and illustrated by Simpson and Henderson (1901) is principally periostracal. The sculpture itself is very difficult to detect, and in specimens where the periostracum has been lost, it is absent. Unfortunately none of the available samples possessed an operculum or the strong bicarinate incrustation of foreign matter adhering to the shell.

Among variable conchological characteristics is the color of the periostracum which may be greenish yellow or pale reddish brown. Perhaps environmental factors, for example, the iron oxide content of the soil, contribute to this phenotypic variation. The degree of deflection of the solute whorl is also variable. An adult gerontic feature, the solute whorl usually separates from the penultimate to maintain a symmetrically discoid shape; however, occasional specimens show some ventral deflection of the solute whorl. Of historical interest is the fact that Pilsbry (1914) called the tendency to form a solute whorl a "phylogerontic" feature, a characteristic of aged forms which reflected their phylogenetic degeneracy.

Isolation has evidently facilitated the development of certain geographically distinct populations of *C. solutus* with distinct phenotypic features. In the Bahoruco Mountains of southwestern Santo Domingo, shells of the species become comparatively larger in size but without a concomitant increase in the degree of soluteness of the last whorl. Specimens from Beata Island, off the south coast of central Hispaniola, tend toward stuntedness and are somewhat smaller; Bartsch (1932) named this population *beatensis*. Since the samples available are too few in number and usually in relatively poor condition, we find that there is insufficient evidence to justify the recognition of these populations, even as subspecies. Moreover, the known range of phenotypic variation in *C. solutus* encompasses the extremes exhibited in such isolates.



Map 1. The distribution of *Ceratodiscus solutus* Simpson and Henderson.

The ecological conditions preferred by *C. solutus* are really unknown since of the available samples, all lack an operculum and were, therefore, apparently not collected alive. The species may be montane since several lots were taken from altitudes of 2000–2500 feet or it may live at virtually sea-level elevations as indicated by its occurrence on Beata and Tortuga Islands. Several field labels show

that samples were collected on or in crevices of limestone rock while the original specimens described by Simpson and Henderson (1901) were found on a talus of red clay along a roadside.

*Specimens examined* (Map 1): HISPANIOLA: HAITI: Point Macon, Ile de la Tortue; 39.8 mi. S of Cap Haitien, Dept. du Nord; La Ferrière (The Citadel), Le Bonnet a l'Eveque, Dept. du Nord; Saint-Raphaël, Massif du Nord, Dept. du Nord; Ennery-Plaisance Road, Massif du Nord, Dept. du Nord. SANTO DOMINGO: Bahoruco Mts., 2500 ft., one hour's walk W from Maniel Viejo (18°04'N; 71°18'W), Prov. de Bahoruco; Beata Island, off Beata Point, Prov. de Pedernales (all USNM).

### *Ceratodiscus minimus* (Pfeiffer)

Plate 46, figs. 1-6; Plate 47, figs. 1-7; Map 2.

*Cyclotus* (?) *minimus* "Gundlach" Pfeiffer, 1859. Malak. Blätt. 6: 68 (type-locality, Monte Toro [Oriente]; holotype 5 × 4 × 1.5 mm, destroyed; paratype, MCZ 86794, Yunque de Baracoa, *ex* (Gundlach); 1860. *ibid.* 7: 26, Yarabo and foot of Yunque on decayed branches, palm-leaves, etc.); 1865. Monographia Pneumonopomorum Viventium, suppl. 2, p. 16; 1869. Novitates Conchologicae, 3: 495 pl. 98, figs. 21-24; Arango, 1879. Contribución Fauna Malacologica Cubana, p. 36.

*Neocyclotus minimus* (Pfeiffer). Kobelt and Möllendorff 1897. Nachrbl. Deutsch. malak. Gesell., 29: 137.

*Crocidopoma minimum* (Pfeiffer). Kobelt, 1902. Das Tierreich, Cyclophoridae, p. 260.

*Ceratodiscus minimus* (Pfeiffer). Thiele, 1927, Arch. Moll. 59: 157, pl. 9, figs. 3-7; Pilsbry, 1927, Nautilus, 41: 63.

*Ceratodiscus ramsdeni* Pilsbry, 1914. Nautilus 27: 134; *ibid.* 28: pl. 1, figs. 6-8 (type-locality, San Carlos Estate, Guantánamo, Oriente; holotype, ANSP 117479a).

*Ceratodiscus camagueyanus* Torre MS [in] Aguayo y Jaume, 1948, Catalogo Moluscos de Cuba, no. 301, El Zonjón de Sibanicú, Camagüey, *nomen nudum*.

*Description.* Shell reaching 4 mm in diameter, planiform, moderately strong, smooth. Whorls almost 4, tube-like, rapidly increasing in size, the last whorl about twice as wide as the penultimate, body whorl well rounded, very shortly solute (about 0.6 mm), not deflected. Color pale buff under a thin, straw-colored periostracum; protoconch and early teleoconch glassy, white. Spire not raised above the first postnuclear whorls and lower than the surface of the last two whorls. Aperture little oblique, subcircular, widely flattened at columellar margin, with a rather wide, shallow groove extending along the columellar side of the solute portion. Peristome thin, entire, slightly flaring. Suture strongly impressed except in the early teleoconch. Sculpture of extremely fine rather widely spaced, spiral striae; irregular incremental lines evident, frequently strongest and most noticeable on the last whorl. Protoconch 1 whorl, rounded, glassy, smooth, faintly and microscopically punctate, variably raised above the early postnuclear whorls. Periostracum thin, glassy, light straw-colored or greenish yellow, occasionally with several low spiral ridges. Operculum as in genus. Umbilicus wide, about 1/3 of base, deep, showing all the whorls.

	Lesser Height Diameter	Greater Diameter	
1.3 mm	3.0 mm	4.0 mm	Loma Santa Cruz, near Senado, Camagüey
1.2	3.7	3.9	Yunque de Baracoa, Oriente
1.0	2.8	3.6	Camayén, Sta. Lucia, Oriente
1.1	2.5	3.4	Guaso, near Monte Líbano, Oriente
1.0	2.4	3.0	San Carlo Estate, Guantánamo Oriente

*Remarks.* *Ceratodiscus minimus* is most easily confused with *C. portoricanus* from which it may be distinguished by its last whorl which is partially solute. From the Hispaniolan *C. solutus*, *C. minimus* is separated by its only partially solute last whorl, its aperture which is flattened along the columellar margin and its subplaniform shape.

Some clinal variation is apparent in *C. minimus*. Specimens in the vicinity of Guantánamo in southern Oriente are somewhat smaller than average while those in Camagüey at the western extremity of the range tend to be larger than average. Both extremes have been described or named. Pilsbry (1914) established *C. ramsdeni* on small specimens from the San Carlos Estate outside Guantánamo which exhibited spiral sculpture only on the first neanic whorl. The exceptionally minute, finely striate sculpture of *C. minimus* is highly variable, most frequently noted in the periostracum, and variously expressed on the surface of the shell — not a feature of specific or diagnostic importance. Aguayo and Jaume (1948) listed a MS name of Torre for specimens from El Zonjón de Sibanicú in north central Camagüey. Although we have not seen this sample which is presumably in the Museo Poey in Havana, we assumed it may be similar to specimens from nearby Loma Santa Cruz, Senado which attain 4 mm in diameter.

Ecological data concerning *C. minimus* are rare. With apparently a considerable range tolerance to altitude, the species is a ground dweller, most frequently associated with decaying vegetation. Pfeiffer (1860: 26) noted the species was found on decayed branches and palm leaves while Arango (1879: 36) remarked that *C. minimus* was found among dead leaves and rotted tree trunks covered with moss. Some specimens are heavily overlaid with a bicarinate black incrustation, peculiar to the genus and noted by earlier workers (Pfeiffer, 1869; Pilsbry, 1914). The nature of this incrustation and its relation to the operculum are discussed in the *Introduction* and the *Remarks* under the genus.

Pfeiffer (1859: 68) transcribed Gundlach's notes on the animal as follows: "The animal itself resembles a *Helicina*. The head is not lengthened anteriorly, but rather bifid, the forehead very oblique with weak oblique ridges as in *Megalostoma*; the tentacles are very elongated, barely diminishing [in width] except suddenly at the very tip; eyes at the outer base not resting on nodules; foot long and flat as in *Helicina* with blunt extremity; body furrowed, whitish, tentacles blackish."



Map 2. The distribution of *Ceratodiscus minimus* (Pfeiffer).

*Specimens examined* (Map 2). CUBA: CAMAGÜEY: Loma Santa Cruz, near Senado (USNM); El Zonjón de Sibanicú (cited in Aguayo and Jaume, 1948). ORIENTE: 2 km N of Uñas, 15 km NW of Holguín; Loma, 4 km S of Uñas, 12 1/2 km NW of Holguín; Loma de la Loma Pichín, El Yayal, Holguín; Cañada, Jagüeyes, Holguín; Loma del Rey, Baguanos, Holguín (all MCZ); Santa Lucia Hill; Camayén, St. Lucia (both USNM); Nipi Hills, Tibisi near Miranda; Cayo del Rey, c. 30 mi. from Miranda; Mercedes Valley, Miranda; mogote 8 km SE of Miranda; Arroyo de Agua near Miranda; Peloncito Hill, Ensenada de Mora; near summit Ensenada de Mora (all ANSP); Yunque de Baracoa (MCZ); Rio Guaso, near Monte Líbano; San Carlos Estate, near Guantánamo (both USNM); Canastus, Guantánamo (MCZ).

**Ceratodiscus portoricanus** Pilsbry & Vanatta

Plate 48, figs. 1-8; Map 3

*Ceratodiscus portoricanus* Pilsbry & Vanatta, 1927. Proc. Acad. Nat. Sci. Philadelphia 79: 21, text figure (type-locality, Montoso, 2624 feet, Division of Mayagüez, Puerto Rico, type ANSP 141925); van der Schalie, 1948. Land Freshwater Mollusks Puerto Rico, Misc. Publ., Mus. Zool. Univ. Michigan, no. 70, p. 24, pl. 1, figs. 8a-c.

*Description.* Shell 3 to 4 mm in diameter, planiform, fragile, translucent, smooth. Whorls 4 1/2, well rounded, increasing rapidly, body whorl more than twice as wide as penultimate, extremely shortly solute, if at all, and slightly descending. Color glassy white under thin straw-colored periostracum, with opaque white axial streaks. Spire depressed, sunken below level of body whorl. Aperture slightly oblique, subcircular, flattened at inner lip. Peristome thin, entire, barely flaring. Suture strongly impressed. Sculpture of weak, regularly spaced axial threads, as wide as their interspaces, and deeper, widely spaced spiral grooves as in some species of *Retinella*; irregular incremental lines strongest on last whorl. Protoconch 1 whorl, rounded, unmarked except for surface pebbling, the spiral threads usually appearing at the third whorl of the teleoconch. Periostracum very thin, pale horn color, with widely spaced low spiral ridges, especially noticeable on the base; some specimens have a thick, broken, dark brown incrustation; umbilicus very wide and deep showing all the whorls; operculum as in genus.

Height	Diameter	
1.3 mm	4.4 mm	west of Río Arecibo, Arecibo District
1.4	4.0	east of Río Arecibo, Arecibo District
1.1	3.7	Cerro Gordo, Aguadillo District
1.5	4.0	Cerro El Gigante, Ponce District

*Remarks.* *Ceratodiscus portoricanus* is very similar to the Cuban *C. minimus*. The last whorl in *portoricanus* is



virtually never truly solute, the columellar wall of the peristome remaining tangential to the penultimate whorl. In *minimus* the last whorl is definitely free, being distinctly separated from the penultimate whorl. Other distinguishing features are very difficult to discern. The spiral striae in the sculpture in *portoricanus* are more widely spaced than those in *minimus* (compare Plate 48, fig. 4 with Plate 47, fig. 7).

Restricted to Puerto Rico, *C. portoricanus* is most common in the western half of the island, where van der Schalie (1948) documented its occurrence. Examination of the series collected by him shows that *C. portoricanus* is the least variable of the known members of the genus. The extremely fine spiral striations are apparent on most specimens as is the glassy protoconch. Somewhat strengthened incremental axial lines, particularly on the last whorl may be indicative of seasonal alterations in growth. The operculum, when present, is usually not covered by the heavy incrustations which are found in *minimus*. Living specimens, as remarked by van der Schalie (1948), usually have soil attached to the shell giving the whorls a bicarinate appearance. Certainly the amount of adhering material is variable, for many specimens have simple irregular patches of dirt scattered over the shell or imbedded in the sutures. Plate 48, figs. 7 & 8, illustrates a specimen with a well developed bicarinate coat of dirt firmly cemented on the shell, probably, as has been suggested in the *Introduction*, with mucus secreted from the foot and directed by the operculum.

Very little is known of the ecological conditions preferred by *Ceratodiscus portoricanus*. It is found both in higher altitudes, the type-series coming from the summit of Montoso at over 2600 feet, and near sea level, at which it has been found near the mouth of Río Guajataca. There is some indication that, as to be expected, limestone outcrops form suitable habitats as do moist areas, such as river banks.

Pilsbry and Vanatta (1927) indicated that the "immature" depressed *Cyclotus* from Caguana, near Utuado, mentioned by Martens (1877) is probably *C. portoricanus*.

*Specimens examined.* (Map 3). PUERTO RICO: AGUADILLA DISTRICT: Cerro Gordo; mouth of Río Guajataca; Pico Montoso (all ANSP); 12 km S of Quebradillas on Road 34; moist hillside at km 24 on Road 18 from Arecibo to Lares; about 3 km SE of San Sebastian on Road 8 (all UMMZ). MAYAGÜEZ DISTRICT: km 2 S of San Germán on Road 39 to Lajas (UMMZ). ARECIBO DISTRICT: Río Arecibo (ANSP); 6.9 km W of Morovis (USNM); outcrop along road to Utuado, 17 km S of Arecibo, limestone just S of Guajataca Forestry station, 15 km S of Arecibo; S bank of Manatí River, 9 km S of Manatí; limestone knoll SE of Vega Baja, 1 km S on road to Morovis; 11-12 km SE of Vega Baja on road to Morovis; limestone outcrops in cafetal 5 km E of Morovis (all UMMZ). PONCE DISTRICT: Adjuntas; Cerro El Gigante (both ANSP); km 21 on road from Ponce to Adjuntas; Finca Pagan, limestone knoll across valley, 19 km NW of Ponce (both UMMZ). San Juan District: riverbank, N of Corozal (UMMZ).



Map 3. The distribution of *Ceratodiscus portoricanus* Pilsbry and Vanatta, modified after van der Schalie, 1948.

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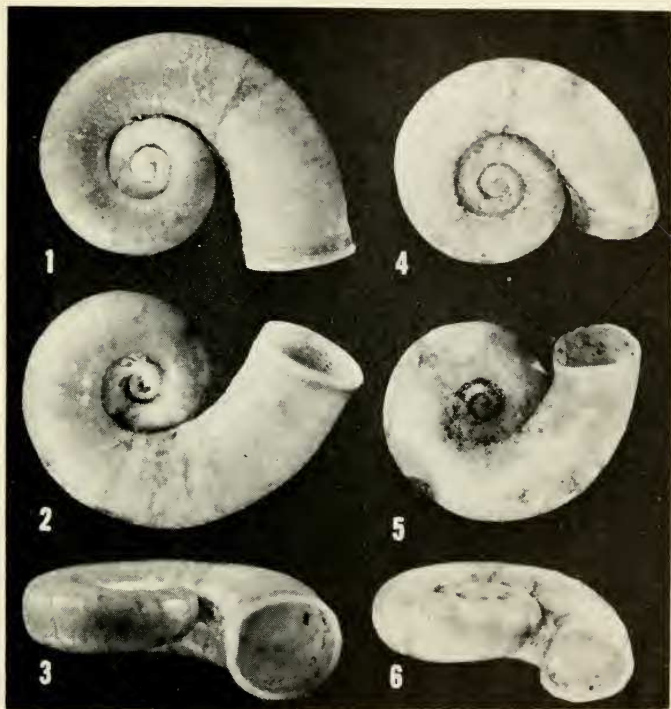


Plate 45

*Ceratodiscus solutus* Simpson and Henderson 1901

Figs. 1-3. Paratype of *Ceratodiscus solutus* Simpson and Henderson 1901, La Ferrière (The Citadel), Le Bonnet à l'Éveque, Dept. du Nord, Haiti, Hispaniola,  $4.3 \times 1.4$  mm, USNM 490059.

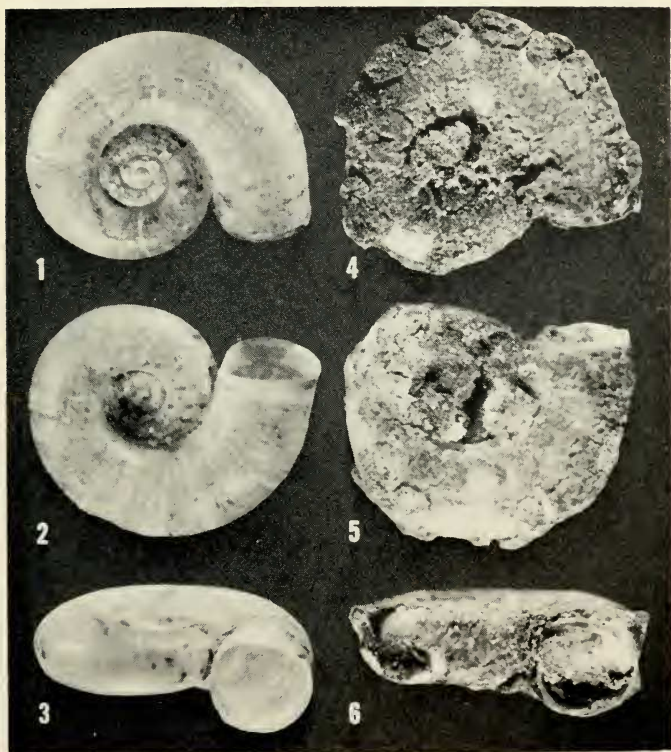
Figs. 4-6. Paratype of *Ceratodiscus beatensis* Bartsch 1932 (= *C. solutus*), Beata Island, Santo Domingo,  $3.8 \times 1.1$  mm, USNM 403897.

## Plate 46

*Ceratodiscus minimus* Pfeiffer 1859

Figs. 1-3. Paratype of *Ceratodiscus minimus* "Gundlach" Pfeiffer 1859, Yunque de Baracoa, Oriente, Cuba,  $4.3 \times 1.6$  mm, MCZ 86794.

Figs. 4-6. The same but with bicarinate incrustation still present,  $4.6 \times 1.7$  mm.



## Plate 47

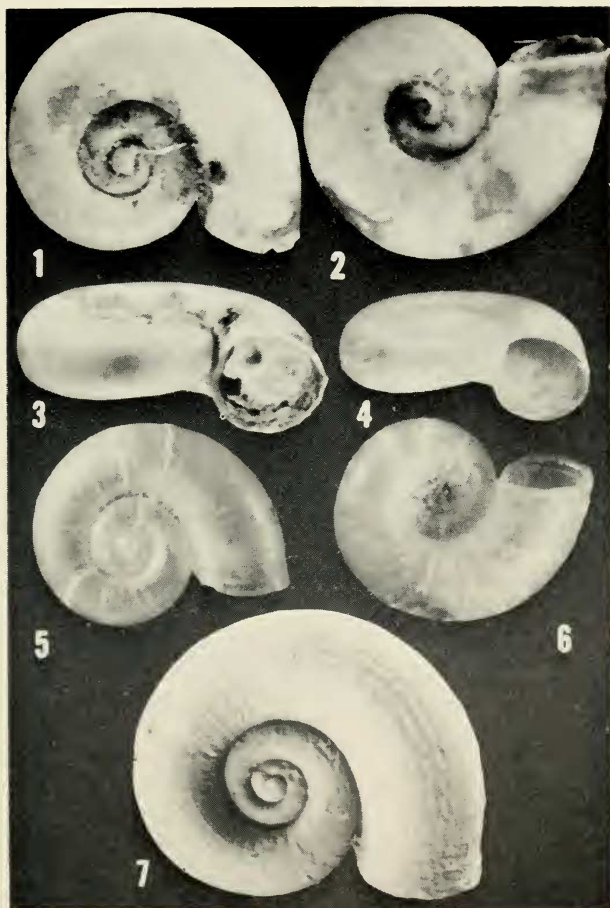
*Ceratodiscus minimus* Pfeiffer 1859

Figs. 1-3. Canastus, Guantánamo, Oriente, Cuba,  $3.6 \times 1.2$  mm, MCZ 178311.

Figs. 4-6. Paratype of *Ceratodiscus ramsdeni* Pilsbry 1914 (= *C. minimus* Pfeiffer 1859), San Carlos Estate, Guantánamo, Oriente, Cuba,  $2.9 \times 0.9$  mm, USNM 490064.

Fig. 7. Paratype of *Ceratodiscus minimus* Pfeiffer 1859, same specimen as in Plate 2 but sprayed with magnesium to show spiral striations.





## Plate 48

*Ceratodiscus portoricanus* Pilsbry and Vanatta 1927

Figs. 1-3. Finca Pagan, 19 km NW of Ponce, Puerto Rico,  $3.8 \times 1.1$  mm, UMMZ 159067.

Figs. 4-6. Km 21 on road from Ponce to Adjuntas, Puerto Rico,  $4.0 \times 1.2$  mm, UMMZ 159063.

Figs. 7-8. S of Guajataca Forestry Station, 15 km S of Arecibo, Puerto Rico,  $3.0 \times 0.9$  mm, specimen sprayed with magnesium to show incrustation, UMMZ 159066.

